

Missouri Department of Natural Resources
Water Pollution Control Program

Total Maximum Daily Loads (TMDLs)

for

Clear Creek
Barry County, Missouri

Completed July 22, 1999
Approved December 1, 1999

Clear Creek (Monett, Missouri)
Final TMDLs (Total Maximum Daily Load)
For BOD, Ammonia, and Suspended Solids
(three TMDLs total)

Waterbody: Clear Creek

Missouri WBID No.: 3239

Missouri Class: C (Class C streams may cease flow in dry periods but maintain permanent pools which support aquatic life)

Beneficial Uses: Livestock and Wildlife Watering, Protection of Warm Water Aquatic Life and Human Health - Fish Consumption

Pollutants: Biological Oxygen Demand (BOD)
Suspended Solids (NFR)
Ammonia (NH_3)

TMDL Priority: High

1. Description of Waterbody, Pollutant(s) of Concern, Pollutant Source(s) and Priority Ranking

Clear Creek, Missouri WBID No.: 3239, is a Class 'C' Ozark stream. Class C streams may cease flow in dry periods but maintain permanent pools that support aquatic life. A three-mile segment of this stream is impaired for aquatic life, livestock and wildlife watering, and fish consumption. The impaired segment stretches from Sec. 36 to Sec. 28 of T26N & R28W in Barry County and has a high TMDL priority ranking. The three pollutants of concern are Ammonia, BOD, and Suspended Solids (NFR - nonfilterable residue).

Monett Wastewater Treatment Plant (WWTP) is the sole source of pollution in Clear Creek. The WWTP serves the entire city of Monett, including sizeable discharges of organic wastewaters from food processing industries located within the city. Recurring mechanical problems at the WWTP and intermittent flows of high BOD influent from food processing industries within the city led to frequent exceedences of the NPDES permits (BOD and NFR monthly averages of 30 mg/l).

The Missouri Attorney General's Office initiated legal action in December 1988, against the city due to chronic noncompliance with permit limits.

Clear Creek had exceedences of state Water Quality Standards for dissolved oxygen (DO) and ammonia for 2-3 miles downstream of the discharge point during periods when the WWTP was operating normally and caused occasional severe water quality problems for many more miles when the WWTP was not operating properly. State Water Quality Standards require a minimum of 5.0 mg/l-dissolved oxygen or maintenance of at least the normal "background" dissolved oxygen minimum. Standards also require a maximum of 2-mg/l ammonia-N in summer, 3.1 mg/l spring and fall and 3.2 mg/l in winter in Clear Creek. A water quality study[1] in September 1978, found dissolved oxygen levels of 2-3 mg/l two miles downstream of the outfall, ammonia levels of 7.5-11 mg/l just below the discharge and 2-3 mg/l two miles downstream. In water quality studies done in July and September 1985, dissolved oxygen levels were at or slightly below 2 mg/l one mile downstream and 2-2.5 mg/l two miles downstream. Ammonia levels were 2-3 mg/l just downstream of the discharge and about 1.5-2 mg/l one mile downstream. At various times during these surveys and other times when the stream was observed by DNR personnel, deposits of solids discharged by the WWTP were also noted to be a problem. Missouri DNR, Water Pollution Control Program, used the data from the water quality surveys conducted in 1978 and 1985 to configure and verify the Qual2e water quality model of approximately 3.5 miles of Clear Creek below the wastewater discharge. This model was then used to predict reductions in effluent strength of CBOD and ammonia necessary to meet instream water quality standards. This model was completed in March 1990, and was subsequently forwarded to USEPA Region VII for review.

2. Description of the Applicable Water Quality Standards and Numeric Water Quality Target

Missouri's Water Quality Standards are in 10CSR20-7.031. There are no state water quality standards for BOD. BOD is of concern because it can cause low levels of dissolved oxygen in receiving waters. The Missouri dissolved oxygen standards are used in this TMDL as the surrogate for BOD. The DO standard is linked to the BOD loading, and this TMDL sets the load allocations of BOD in order to meet the water quality standards for DO. This linking is accomplished by using the Qual2e model.

Applicable numeric (acute) criteria for ammonia and dissolved oxygen within mixing zones:

Pollutant	Summer	Spring & Fall	Winter
Ammonia	22.4 mg/l	24.6 mg/l	25.8 mg/l
Dissolved Oxygen	3.0 mg/l		

Applicable numeric criteria for ammonia and dissolved oxygen beyond mixing zones:

Pollutant	Summer	Spring & Fall	Winter
Ammonia	2.0 mg/l	3.1 mg/l	3.2 mg/l
Dissolved Oxygen	5.0 mg/l or normal "background" DO minimum		

If the 5-mg/l concentration of DO beyond the mixing zone cannot be maintained under natural conditions, the Missouri standards allow the natural DO profile of the stream to be used. For this segment, the applicable DO standard is a warm weather 7-day mean minimum of 4 mg/l.

[1] Stream Surveys of Clear Creek were completed by the Missouri DNR, Environmental Services Program, in Sept. 1978 and July and Sept. 1985. Reports were not published but are on file at the MDNR, Water Pollution Control Program, Jefferson City, Mo.

The applicable criterion for suspended solids is the narrative criterion in 10 CSR 20-7.031 section (3)(C) that states:

"Waters shall be free from substances in sufficient amounts to cause unsightly color or turbidity, offensive odor or prevent full maintenance of beneficial uses."

Instream deposition of suspended solids is also addressed by another portion of the narrative criteria, section (3)(A) that states:

"Waters shall be free from substances in sufficient amounts to cause the formation of putrescent, unsightly or harmful bottom deposits or prevent full maintenance of beneficial uses."

Missouri links this suspended solids narrative standard to a numeric criterion based on experience at other relatively large wastewater discharges into small receiving streams. This experience has shown that a suspended solids concentration of 30 mg/l is protective year round. As a result, the narrative suspended solids standard is interpreted as a numeric target concentration of 30 mg/l, which can be converted using the flow into a numeric target loading for suspended solids.

Missouri's Water Quality Standards include the EPA "three-tiered" approach to anti-degradation.

Tier 1 defines baseline conditions for all waters. It requires that existing beneficial uses be protected. TMDLs would normally be based on this tier, assuring that numeric criteria such as dissolved oxygen and ammonia concentrations are met to protect uses.

Tier 2 requires no degradation of high-quality waters, unless limited lowering of quality is shown to be necessary for "economic and social development." A clear implementation policy for this tier has not been developed, although if sufficient data on high-quality waters are available, TMDLs could be based on maintaining existing conditions, rather than the minimal Tier 1 criteria.

Tier 3, the most stringent tier, applies to waters designated in the Water Quality Standards as outstanding state and national resource waters. Tier 3 requires no degradation under any conditions. Management may require no discharge or prohibit certain polluting activities. TMDLs would need to assure no measurable increase in pollutant loading.

These TMDLs satisfy Tier 1 of Missouri's anti-degradation policy, since after these TMDLs have been implemented, water quality in the impaired segment will be improved and meet the applicable standards, and the beneficial uses will be protected.

3. Loading Capacity – Linking Water Quality and Pollutant Sources

The loading capacity of a pollutant is calculated from the flow and the instream numeric criterion. The flow is variable, and the worst-case value used to calculate the loading capacity. The worst-case condition for WWTP discharges is the low flow condition. Missouri uses the 7Q10 for the low flow value.

The loading capacity can be calculated at any point within a stream. In this TMDL, the pollutant source is a WWTP discharge. Missouri statutes allow WWTP discharges to have a mixing zone, and requires only acute criteria to be met within this mixing zone. The chronic criteria must be met

beyond the allowed mixing zone. In these TMDLs, the loading capacity is calculated at the WWTP discharge pipe, before the mixing zone. Therefore, the instream water quality standard that must be met at the end of the mixing zone must be linked to the pollutant concentration or load in the discharge. This link is provided by the Qual2e model.

Requiring the instream concentration of each pollutant meet the instream water quality standard at the end of the mixing zone, the Qual2e model predicted the end-of-pipe maximum concentration allowable. The allowable CBOD concentration is 5.5 for summer and 10mg/l for winter. The allowable ammonia N concentration is 2.8 for summer, 4 for spring/fall, and 3.8 mg/l for winter. Missouri believes that BOD and CBOD are equivalent for the purposes of managing dissolved oxygen, and use the two interchangeably in this TMDL (see footnote 2).

Since the 7Q10 low flow is zero, the design flow for Clear Creek is the design flow of the Monett WWTP, 3.7 MGD or 5.7 cfs. Using Formula 1 below, the CBOD[2] load capacity as determined in the discharge from the WWTP is 154 pounds in spring, fall and summer and 308 pounds in winter. Ammonia load capacity in the discharge is 123 pounds/day in spring and fall, 86 pounds/day in summer and 117 pounds/day in winter.

(CBOD in mg/l)(Flow in cf/s)(5.4) = (Pounds per day) (1)

Based upon experience at other relatively large wastewater discharges to small streams[3], a suspended solids concentration of 30 mg/l was felt to be protective year round. Using Formula One this would result in a suspended solids load capacity of 924 pounds per day.

These loading capacities are for the WWTP discharge, and may be allocated to the wasteload. As mentioned before, the upstream flow is zero at the critical condition, and so the upstream load contribution is zero for these pollutants. These loading capacities will result in the attainment of the water quality standards beyond the allowed mixing zone for all the pollutants.

4. Load Allocation (LA)

All loads to Clear Creek during conditions when Water Quality Standards exceedences occur are point source loads. There are no non-point source loads during water quality critical periods. Therefore, the load allocations for all pollutants in these TMDLs are zero because there is no upstream flow at the 7Q10 low flow and only very rarely at other times due to the losing stream nature of upper Clear Creek and tributaries.

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[2] CBOD would be 5 mg/l less than BOD.

[3] A review of receiving stream impacts below 179 wastewater lagoons and 77 mechanical wastewater treatment plants was conducted in 1999. Lagoons allow NFR limits of 60 to 80 mg/l. Forty-nine of the 179 lagoons queried (27%) had observed instream impairment due to suspended solids. Only 2 of 77 mechanical plants (3%) had observed instream impairment due to suspended solids. Mechanical plants have NFR limits that are typically 30 mg/l with a few plants having 45 mg/l limits. Thus, we believe that NFR limits of 30-45 are generally protective while limits above 60 may not be. We believe this provides justification for the use of 30 mg/l as the proposed point source load concentration for suspended solids.

5. Wasteload Allocation (WLA)

The wasteload allocation of the single point source is the loading capacity minus the load allocation minus the margin of safety minus the load allocation reserved for future growth. The allocation reserved for future growth is zero. The wasteload allocations for the Monett WWTP are:

(loading capacity) - (margin of safety) - (load allocation) - (held in reserve) = wasteload allocation

Suspended Solids (discharge from the pipe):

(924 lb/da) - (462 lb/da) - (0) - (0) = 462 pounds per day suspended solids year round

CBOD (discharge from the pipe):

Spring Summer Fall:

(154 lb/da) - (15.4 lb/da) - (0) - (0) = 138.6 pounds per day CBOD

Winter:

(308 lb/da) - (30.8 lb/da) - (0) - (0) = 277.2 pounds per day CBOD

Ammonia as N (discharge from the pipe):

Spring Fall:

(123 lb/da) - (12.3 lb/da) - (0) - (0) = 110.7 pounds per day NH_3 as N

Summer:

(86 lb/da) - (8.6 lb/da) - (0) - (0) = 77.4 pounds per day NH_3 as N

Winter:

(117 lb/da) - 11.7 lb/da) - (0) - (0) = 105.3 pounds per day NH_3 as N

Summarizing, 462 pounds per day of suspended solids is allocated to the Monett WWTP discharge before the mixing zone. The CBOD allocations to the discharge before the mixing zone are 138.6 pounds per day for spring, summer, and fall, and 277.2 pounds per day for winter. The ammonia N allocations to the discharge before the mixing zone are 110.7 pounds per day for spring and fall, 77.4 pounds per day for summer, and 105.3 pounds per day for winter.

If monitoring data indicates that applicable water quality standards are not being met, these TMDLs will be reopened and these allocations will be re-evaluated.

6. Margin of Safety

These TMDLs are based on technical work performed in the 1980s and early 1990s, which resulted in the issuance of an NPDES permit and a WWTP upgrade that was completed in 1996. This prior work allocated the maximum loading to the discharging facility that would meet instream applicable water quality standards.

When a model, such as Qual2e, is used to determine allowable loading, it is acceptable to use an implicit margin of safety by selecting conservative estimates of model parameters. The implicit margin of safety is not selected in these TMDLs because conservative estimates were not selected. The margins of safety in these TMDLs are being set as follows:

BOD: The Qual2e Model predictions performed in the early 1990s of in-stream dissolved oxygen showed that none of the seasonal limits will allow maintenance of 5 mg/l dissolved oxygen, and advanced water treatment limits were placed in the NPDES permit. More recent data does not exist, and therefore, it is not possible at this time to obtain quantitative estimates of the uncertainty in the predicted instream dissolved oxygen due to BOD loading. Therefore, the margin of safety for the BOD loading is set at 10% of the loading capacity. If in the future, monitoring data shows that the DO standard is not attained, then this TMDL will be re-opened and the margin of safety will be re-evaluated. The margin of safety for BOD is 15.4 pounds per day in spring, summer, and fall, and 30.8 pounds per day in winter. These numbers apply to the loading at the discharge of the WWTP.

Ammonia: The ammonia limits in the issued NPDES permit were set based on allocating 100% of the load capacity to the Monett WWTP. More recent data does not exist, and therefore, it is not possible at this time to obtain quantitative estimates of the uncertainty in the predicted instream ammonia concentration beyond the mixing zone. Therefore, the margin of safety of the ammonia loading is set at 10% of the loading capacity. In the future, if the monitoring data shows that the ammonia standard is not attained, then this TMDL will be re-opened and the margin of safety will be re-evaluated. The margin of safety for ammonia is 12.3 pounds per day in spring and fall, 8.6 pounds per day in summer, and 11.7 pounds per day in winter. These numbers apply to the loading at the discharge of the WWTP.

Suspended Solids: Based on experience with large WWTP discharges to low flow streams, Missouri selected 50% of the load capacity for suspended solids as the margin of safety, which is 462 pounds per day year round. This number applies to the discharge of the WWTP.

7. Seasonal Variation

Seasonal variation has been addressed by establishing seasonal effluent limits at the Monett WWTP based on seasonal simulations using the Qual2e model.

Seasonal limits for BOD and Ammonia are necessary because decay of these substances is biologically mediated and varies with water temperature and because dissolved oxygen gas saturation varies with water temperature. The impact of suspended solids on the receiving stream is primarily physical (smothering of natural stream substrate) and is not related to water temperature or other seasonal effects

8. Monitoring Plan for TMDLs Developed under the Phased Approach

These are phased TMDLs. The facility completed an upgrade in the WWTP in 1996. DNR conducted a water quality survey of Clear Creek below the Monett WWTP in August 1999, and will conduct an additional water quality and invertebrate study of Clear Creek and a nearby stream without a point source discharge in 2000. The August data has not yet been evaluated. If these studies show compliance with Water Quality Standards, the TMDL will be considered completed. If these studies show noncompliance with Water Quality Standards, the data from these studies will be used to further refine the Qual2e stream model and the suspended solids allocation, as appropriate. If water quality standards are not met, these TMDLs will be re-opened and Missouri will re-evaluate the loading capacity and allocations, as appropriate. Then new water quality based permit limits will be issued that are protective of state water quality standards.

9. Implementation Plans

These TMDLs will be incorporated into Missouri's Water Quality Management Plan.

In prior work, an undated letter from Timothy Amsden, Acting Director of the Water Management Division, received by DNR July 9, 1990, contained EPA's approval that the model and its predicted acceptable effluent limits constituted an acceptable advanced treatment review for an EPA grant to fund new construction at Monett WWTP. A copy of the model and recommended treatment limits is included as an appendix.

NPDES Permit MO 0021440 was subsequently reissued and included a schedule of compliance that required the Monett WWTP to meet the following effluent limits (in mg/l) by August 15, 1996:

Pollutant	Spring/Fall	Summer	Winter
BOD	10	10	10
NFR	15	15	15
Ammonia-N	4.0	2.8	3.8

An upgrade of the Monett WWTP to meet these new water quality based limits was completed on schedule.

Presently, Missouri conducted a water quality survey in August 1999 and is in the process of evaluating the data. Missouri will conduct additional water quality monitoring and an invertebrate study in 2000. If these studies indicate that the applicable water quality standards are met, then these TMDLs will be successfully implemented. If not, then these TMDLs will be reopened and re-evaluated and modified as appropriate so that the instream water quality will meet the applicable Water Quality Standards.

10. Reasonable Assurances

There are no nonpoint sources of the pollutants in this segment, and the NPDES permit is the authority that assures the sole discharging point source facility will meet the wasteload allocations in these TMDLs.

11. Public Participation

The Missouri Department of Natural Resources, Division of Environmental Quality, Water Pollution Control Program, developed this TMDL. These TMDLs were public noticed from April 2 to May 7, 1999. Six public meetings to allow input from the public on impaired waters were held between August 18 and September 22, 1999. No comments pertaining to Clear Creek were received during the public notice or the public meetings.

12. Administrative Record

An Administrative Record for these TMDLs is being maintained by the Missouri DNR.

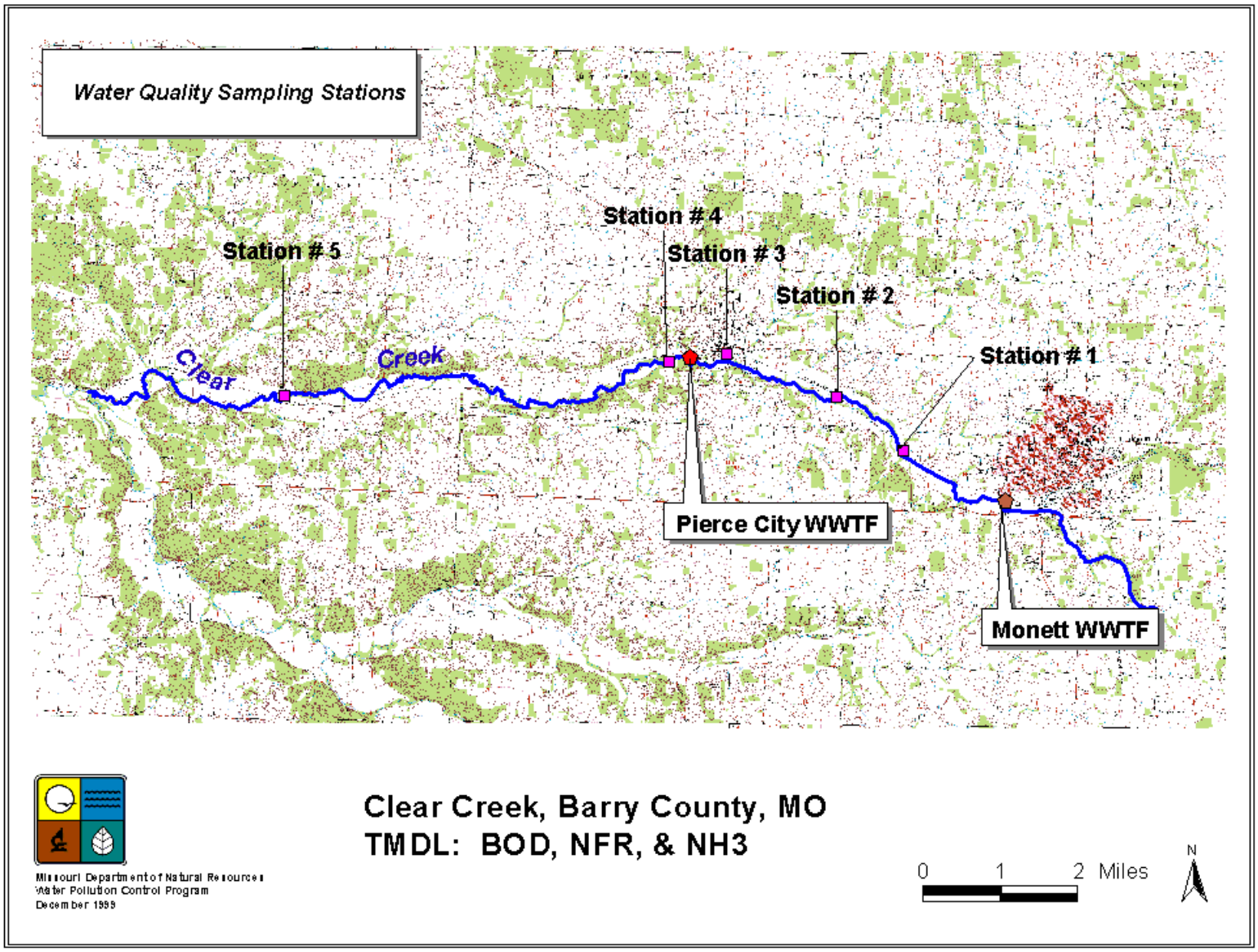
13. Data and Information Sources

The Missouri Department of Natural Resources, Environmental Services Program (ESP), in cooperation with the Water Pollution Control Program, collected all chemical and flow data pertaining to the impaired stream segment. This data and information is available upon request.

References Maintained as Administrative Record

1. Qual2e output

2. Mixing zone provisions of Missouri's Water Quality Standards (10 CSR 20-7.031(4)(A)(5))


Water Quality Sampling Stations
Station # 5
Station # 4
Station # 3
Station # 2
Station # 1
Clear
Creek
Pierce City WWTF
Monett WWTF
Missouri Department of Natural Resources
Water Pollution Control Program
December 1999
Clear Creek, Barry County, MO
TMDL: BOD, NFR, & NH3
0
1
2 Miles
N